UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MATERIALS SELECTION FOR CONCEPTUAL AUTOMOTIVE HOOD DESIGN USING FINITE ELEMENT ANALYSIS

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design) (Hons.)

by

MOHD RIDZWANIL HANIF BIN RUSLAN

B051010081

861220-02-5459

FACULTY OF MANUFACTURING ENGINEERING

2013

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **MATERIALS SELECTION FOR CONCEPTUAL AUTOMOTIVE HOOD DESIGN USING FINITE ELEMENT ANALYSIS**

SESI PENGAJIAN: 2012/13 Semester 2

Saya **MOHD RIDZWANIL HANIF BIN RUSLAN**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.

☐ SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysiasebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)

☐ TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

☒ TIDAK TERHAD

Disahkan oleh:

_____ _____

Alamat Tetap:
A 66,Felda Pasir Besar,
72430 Gemas, Negeri Sembilan.

Cop Rasmi:

Tarikh: _____.

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled “materials selection for conceptual automotive hood design using finite element analysis” is the results of my own research except as cited in references.

Signature	:	…….
Author’s Name	:	MOHD RIDZWANIL HANIF BIN RUSLAN
Date	:	3 JUNE 2013

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia (UTeM) as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) (Hons.). The member of the supervisory is as follow:

……

(Project Supervisor)

Engr. Dr. Hambali bin Arep@Ariff

ABSTRAK

Sejak kebelakangan ini, gentian asli muncul menjadi bahan sisa yang dapat menggantikan gentian sintetik yang mahal harganya. Diantara bahan yang digunakan untuk fabrikasi automotif hud seperti Aluminum Alloy, Magnesium Alloy, Carbon *fiber* dan gentian asli adalah Kenaf diperkukuhkan dengan Polipropilena. Projek ini secara keseluruhannya membincangkan tentang potensi komposit gentian serat semulajadi terhadap industry automotif dalam rekabentuk hud kereta. Matlamat utama projek ini adalah untuk menentukan bahan yang sesuai untuk digunakan dalam fabrikasi hud kereta. Perisian *CATIA* digunakan untuk merekabentuk semula hud kereta dan mengunakan perisian *SolidWorks Simulationxpress* untuk melakukan analisa. Selepas itu daripada keputusan analisa, perbandingan dibuat dari segi jisim, tekanan, anjakan dan faktor keselamatan digunakan untuk pemilihan bahan. Daripada keputusan analisis, data tersebut dimasukan ke dalam *scoring process* dan dibincangkan dengan lebih terperinci. Potensi komposit gentian serat semulajadi akan dikaji berdasarkan keputusan analisis tersebut. Berdasarkan data analisis yang diperolehi hasil daripada ujikaji yang dijalankan, Magnesium Alloy adalah bahan yang sesuai untuk menghasilkan hud automotif. Walau bagaimanapun, gentian Kenaf diperkukuhkan dengan Polipropilena mempunyai potensi untuk mengantikan bahan sedia ada yang digunakan dalam pembuatan hud kereta. Untuk cadangan dalam penyelidik akan datang adalah untuk menguji menggunakan analisis dinamik kemudian, ujian kesan sebenar pada hud automotif direka perlu menjalankan untuk mendapatkan hasil eksperimen. Hasil eksperimen boleh dibandingkan dengan analisis yang telah dibuat sebelum ini dan juga boleh menentukan penyerapan tenaga daripada bahan-bahan yang digunakan.

ABSTRACT

In recent years natural fiber appear to be the outstanding materials which come as the viable and abundant substitute for the expensive and non-renewable synthetic fiber. Among the materials used for the fabrication of automotive hood such as Aluminum Alloy, Magnesium Alloy, Carbon fiber and natural fiber is Kenaf Fiber reinforced Polypropylene. This project overall is discussed about the potential of natural fiber composite in automotive industry to develop the automotive hood. The main objective in this project is to determine the appropriate material to be used in fabricating automotive hood. From design a hood car by using CATIA CAD Software and conduct the design analysis using SolidWorks Simulation software. Redesign the automotive hood is done in the CATIA CAD. SolidWorks Simulationxpress software was used for Finite Element Analysis. For the comparison, the mass, stress, displacement and factor of safety is used for materials selection. From the results, the data were through the scoring process and discussed in detail based on the result from the Finite Element Analysis. Based on analysis of data obtained as a result of the test, the Magnesium Alloy is the best material for fabricated automotive hood. However, Kenaf fiber reinforced with polypropylene has the potential to replace existing materials used in the manufacture of car hood. For the recommendation in the future researcher is to test using Dynamic analysis then, an actual impact testing on the fabricated automotive hood should be conduct to obtain an experimental result. The experimental result could be compared with the analysis that has been made before and also can determine energy absorption of the materials used.

DEDICATION

To my beloved parents, of course;
To my lecturers, my friends and to all members of the
Faculty of Manufacturing Engineering.

ACKNOWLEDGEMENT

The special thank goes to my helpful supervisor, Engr. Dr. Hambali bin Arep@Ariff the supervision and support that he gave truly help the progression and smoothness of the project. The co-operation is much indeed appreciated. A big contribution and hard worked from you during the completion of this project is very great indeed. All projects during the program would be nothing without the enthusiasm and imagination from you. Great deals appreciated go to the contribution of my faculty - Faculty of Manufacturing Engineering (FKP). An appreciation also goes to my parents for their love and moral support. Last but not least I would like to thank my friends especially those who work together my PSM group under Engr. Dr. Hambali bin Arep@Ariff.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CAD	-	Computer Aided Design
CBU	-	Completely built-up Units
CFRP	-	Carbon Fiber Reinforced Plastics
FEA	-	Finite Element Analysis
FOS	-	Factor of Safety
FYP	-	Final Year Project
GFRP	-	Glass Fiber Reinforced Plastics
kJ	-	Kilo Joule
LSTC	-	Livermore Software Technology Corporation
N	-	Newton
PEEK	-	Polyether ether ketone
PSM1	-	Projek Sarjana Muda 1
PSM2	-	Projek Sarjana Muda 2
RTM	-	Resin Transfer Mold
SHF-P	-	Sheet Hydroforming- Process
UK	-	United Kingdom
3D	-	Three Dimension

CHAPTER 1
INTRODUCTION

Overall this chapter discusses about the briefing of the background, problem statement, objectives and scope of project.

1.2 Background

Nowadays, in the development of technology, especially in the engineering field among the engineers create a more creative and competitive in the form or creating new products. They must be accurate, precise and shows careful attention to what they produce. The biggest demand facing the automotive industry has provided safer vehicles with high fuel efficiency at minimum cost. One option for reduce energy consumption is the weight reduction.

The automotive market is going towards a green approach at the present time, especially because of marketing purposes. Thus, automotive industries are starting to project and design cars with less environmental impact. This process is pursued through many different ways. The most known and advertised is for sure the reduction in the consumption of fossil fuels. A different way that could be followed in order to reduce the environmental impact is to decrease the quantity of material used for each a part. This reduction of materials brings many different improvements. First of all, it has direct benefits due to a less use of raw materials and energy for parts production. At a second stage, it has an indirect influence on fuel consumption due to the lower weight of the car (less weight implies less consumption) (Tolouei, 2009).

1.2 Problem Statement too short

The hood car is the hinged cover over the engine of motor vehicles that allows access to the engine compartment for maintenance and repair. The hood car available in market now is heavy and finding other alternative to reduce weight on a car component and so the fuel consumption can be reduced. Kenaf leaf fiber is an alternative material to explore the new material instead of existing material and to encourage green product. Automotive hood also one of the related safety features in automobile that need to consider. The target is designing the automotive hood is to achieve low weight and high stiffness.

Most of the researcher focus to replacing the conventional materials by develop and tested the automotive hood with different type of materials, such as conventional material and composite material. From the material result that shows the lower value of the stress indicates the better performance of the material and that can propose as new materials for the automotive hood.

1.3 Objective

The main objective in this project is to determine the appropriate material to be used in fabricating automotive hood. In order to achieve this main objective, these specific objectives need to be carried out:

a) To design a hood car by using CATIA CAD Software,
b) To conduct design analysis using SolidWorks Simulation software.
c) Comparison existing material and Kenaf Fiber Reinforced Polypropylene.

1.4 Scope of project

The scopes of this project are the utilization of CAD software in designing automotive hood, find the mechanical properties of materials in FEA using SolidWorks SimulationXpress, analyzes the compatibility of Kenaf Fiber Reinforced Polypropylene as material used in fabricating automotive hood based on the result of the analysis.

CHAPTER 2
LITERATURE REVIEW

In this section, the focus area is about finding the information of fabricating automotive hood using natural fiber. The existing materials that are used to fabricate automotive hood is also be discussed in this chapter.

2.1 Introduction

A typical automotive body is a complex structure comprised of many sub-assemblies each made of many parts. Often times these parts are sheet metal stampings that must be joined together using spot weld or hemming processes to make the subassemblies. The final shape of automotive structures is not only affected by residual stresses in the individual stamped parts, but often times by the assembly process (Hammett, 1998).

Automotive companies typically use a sequential validation process whereby individual stampings are compared to their printed specifications during the die buy-off stage. If the parts do not conform, then the die is reworked until the stamped parts do conform. Often times this effort is wasted as the part would take its desired shape when joined to a stiffer part during the subsequent assembly process. Alternatively, the assembly process itself can distort the shape of individual panels that were produced within specification. The functional build approach recognizes this fact and attempts to take advantage of it:

relatively cheap assembly fixtures are used to ensure that during assembly the out of spec components are brought within spec (Hammett, 1998).

2.2 Automotive Hood

Today, the automobile industry in Malaysia is getting better and wider day by day. Many improvements have been done to increase the quality of the automotive products and at the same time trying to preserve the environment. In the 1960s, the Malaysian government encouraged the setting up of automobile assembly plants in Malaysia. The main objectives were to reduce the imports of completely built-up units (CBU) that will help to stabilize balance of payments, to create employment and to provide the base for transfer of technology. In the 1970s, the "Local Content Policy" was promoted to enhance the development of local parts and components industry (Mahidin and Kanageswary, 2004). A significant effort made by the automobile and component manufacturers to reduce aerodynamic drag, noise and vibration. Figure 2.1 shows the components of automotive hood.

Figure 2.1: Components of Automotive Hood (Annoy, 2012)

It can also be considered as another door hood of vehicle. It is the gateway to get access to the front of the engine compartment of vehicle engine. (Component called for vehicle rear deck lid engine.) It consists of inner and outer panels. Consists of one-piece frame

bracket crisscrossing, internal panel serves as abdominal support panel off so it would not be easy to flex and get dented. Outer panel, on the other hand, is designed to meet the sheet metal and fenders and edge contour matches the cowl. It under hood system shield from rain, road debris, and any other elements that are not supposed to be in the engine compartment.

Hoods come in designs and styles. There are some who undersides are covered with sound-absorbing material to minimize the roar or sound escape the engine bay. There are also specially designed to accommodate their special accessories, such as a spoon. This is usually found in performance vehicles such as trucks, or sports cars. Very similar to the airways in form and function, allowing the engine bay spoon to "inhale" and "exhale." They installed facing the front end of the vehicle can "scoop" or channel outside air directly to the air filter, which improves engine performance. But there is also a spoon with their openings facing backwards. Instead of taking the air, they are designed to release the hot under hood air, which also helps the performance of the engine.

Usually, the shape and form of the vehicle will carry standard setting design manufacturer. Hood shaped and contoured to perfection to radiate the presence of the day, it also serves as a protective cover for the engine to prevent the intrusion of water and debris. High grade and durable construction effectively shield the rain, snow, hail, or debris that can reach into the car's engine system and disrupt the smooth operations. Maintain a good quality engine ensures excellent performance in keeping it away from damage while only look great on the vehicles front propagation. Hoods are usually crafted from steel and glass or carbon fiber but aluminum construction is getting more and more popular for pliability, strength, and handling characteristics of a perfect if you want to customize the look and shape of the vehicle. It has binders and support that holds it upright and prevents accidents while having routine maintenance done (Annoy, 2012). Secured with locking feature, it is pressed by the latch pin hidden with scarves. For the application of high performance parts, should ensure that a proper latch works to prevent it from opening immediately began to accelerate. For added security features,

design hood modified to limit the severity of pedestrian injuries in the accident. More advanced designs make use of automotive bonnet / hood as actively reject structure a few centimeters away from the hard parts of the motor by means of the spring force mechanical or pyrotechnic devices.

The vehicle consists of a large steel section that forms the body of the vehicle. They were stamped in a particular form and they have been divided to perform different functions. Frame serves as the overall structure of the vehicle body and good anchor point suspension system. One that serves as the floor of the vehicle, which is located at the bottom of the car assembly and also serves as the basis for the vehicle body shell is the floor pan. These are just some vehicle panels designed to provide a solid amount of vehicle systems.

Hood is another body panel that has a specific job to do. It's a body in front of the opening panel cowl that covers the engine in front engine vehicles. In the UK, they are called the "bonnet". They also considered other types of doors that are fitted in the vehicle because they are also made up of the outer panel and the inner panel. Inner panel provides strength while the outer panel only works as a metal cover or function as a "skin" hood (Annoy, 2012).

Usually, under the hood is covered with sound absorbing material. Many scarves are manufactured with a built-in spoon although some can only be added. These spoons are often made of steel, carbon fiber glass. Since the cap is located in the front of the vehicle, they are prone to wear and tear caused by collisions. But other than collision, corrosion or rust also archenemy hood because the hood is exposed to many elements that come from the outside world. The Figure 2.2: shows that, the inner panel (a), the outer panel (b), and the assembly (f) are cropped to prevent identification, a) Hood inner b) hood outer c) main reinforcement d) hood hinge reinforcement e) latch reinforcement f) assembly without the outer panel. Figure 2.2 shows the components to be assembled into the hood assembly.

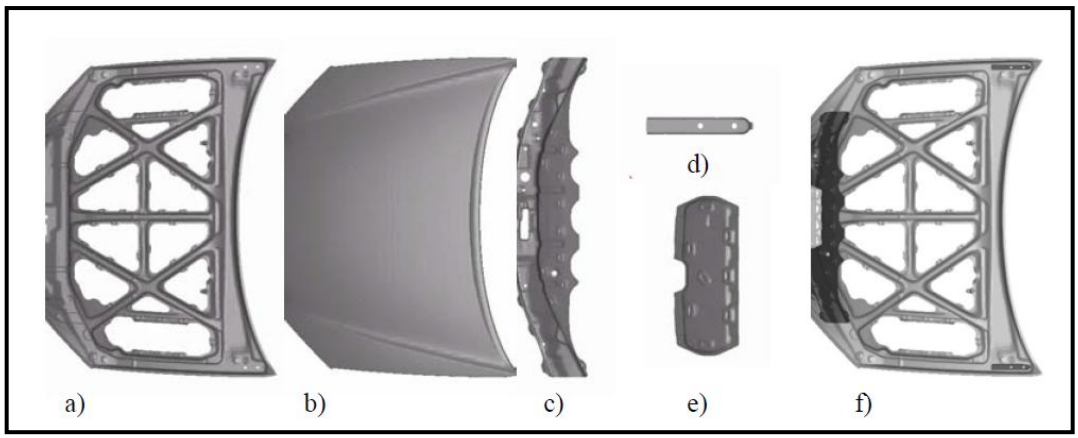

Figure 2.2: Components to be assembled into the hood assembly. (Thomas, 2010)

2.3 Material Used in Manufacturing Automotive Hood

2.3.1 Carbon Fiber Reinforced (CFRP)

Carbon fiber reinforced composites (CFRPs) offer greater stiffness and strength than any other type, but they are considerably more expensive than GFRP. Continuous fibers in a polyester or epoxy matrix give the highest performance. The fibers carry the mechanical loads, while the matrix material transmits loads to the fibers and provide ductility and toughness as well as protecting the fibers from damage caused by processing conditions.

Concern about carbon dioxide emissions and world hydrocarbon fuel reserves means that there is considerable interest in technologies that reduce fuel consumption for passenger cars. In the area of vehicle design, body weight is the most important target for improvement, as a reduction in the weight of a vehicle's body means that a smaller engine, and a lighter drive train and assembly can be used. This 'benign spiral' leads to further mass reductions, so much so that various studies have indicated a potential for savings of up to 65% by using carbon fiber composites instead of steel wherever possible.

Carbon fiber reinforced polymer or carbon fiber reinforced plastic (CFRP or CRP or often simply carbon fiber), is an extremely strong and light fiber reinforced polymer which contains carbon fibers. The polymer is most often epoxy, but other polymers, such as polyester, vinyl ester or nylon, are sometimes used. The composite may contain other fibers, such as Kevlar, aluminum, or glass fibers, as well as carbon fiber. The strongest and most expensive of these additives, carbon nano tubes, are contained in some primarily polymer baseball bats, car parts and even golf clubs where economically viable.

Although carbon fiber can be relatively expensive, it has many applications in aerospace and automotive fields, such as Formula One. The compound is also used in sailboats, modern bicycles, and motorcycles, where its high strength-to-weight ratio and very good rigidity is of importance. Improved manufacturing techniques are reducing the costs and time to manufacture, making it increasingly common in small consumer goods as well, such as the tripods, fishing rods, hockey sticks, paintball equipment, archery equipment, tent poles, racquet frames, stringed instrument bodies, drum shells, golf clubs, helmets used as a paragliding accessory and pool/billiards/snooker cues.

The material is also referred to as graphite-reinforced polymer or graphite fiber reinforced polymer (GFRP is less common, as it clashes with glass fiber reinforced polymer). In product advertisements, it is sometimes referred to simply as graphite fiber for short.

2.3.1.1 Manufacturing Process of Automotive Hood using Vacuum Bagging

Before the material in any resin mixture, make sure have cut the required amount of glass fabric (enough to cover the overlapping part with about 1.5 inches), providing an area to put the vacuum bag where it can sit for a few hours and you've boiled the kettle (if you want to use a hot water bottle to cure faster). Prepared bristle brush and a cup of acetone to clean the mixing cup and brush immediately after use it. Vacuum bags needed